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The role of regional information in the optimal composition of a committee

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Abstract

We analyse the optimal composition of a committee comprising members that have private information and represent constituencies of different economic sizes. 'Proportional representation' - i.e. each constituency represented proportionally to its economic weight - seems intuitively appealing, but as we demonstrate, the optimal committee composition is more complex. We show that representation in a committee depends also on (i) the 'intrinsic' uncertainty of the available data, (ii) constituency's degree of sectoral specialization, and (iii) the extent to which economic developments are correlated between constituencies.

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1. Introduction

Staffing a committee can be a tedious task. In the political arena, an important consideration is that the composition of the committee should strike a balance between different political views, different heritage, etc. An important rationale for local representation – that is, involving delegates from different regions in decisions taken at the national level – is that they have better knowledge of regional circumstances and can bring additional, "local" information that would otherwise risk being neglected. If this argument is correct, then the staffing of the committee might have important implications for the outcome.

We derive conditions for an (informationally) optimal composition of such a committee, based on the idea that disaggregated or regional information is beneficial in taking a (federal) decision. If local delegates are able to provide information otherwise not available, but the overall size of the committee is fixed, a selection between representatives of different regions has to be made. We relate this choice to knowledge about local circumstances, and show that whether or not a certain region is represented in an "optimal" committee depends on their representatives' abilities to contribute to a better assessment of the economic situation. Most importantly, an 'overrepresentation' of small regions - i.e. a weight in the committee that exceeds their economic share - can be beneficial, if the state of their economy is very difficult to assess.

This paper is linked to different strands of the literature. Casella (1992) analyses a country's incentives to join a monetary union. Although the setup of the model is very different (no modelling of information uncertainties), Casella's results are comparable to ours in that small countries may exert larger influences than is warranted by their size. Von Hagen and Süppel (1994) evaluate alternative distributions of power between regional delegates and the administrative centre of a currency union. Hefeker (2003) develops a model based on structural differences across members of a currency union and finds that it can be beneficial to limit the representation of regions if their structure is too different from the rest of the currency area. Meade and Sheets (2005) consider the monetary policy decisions of the US Federal Reserve. They allow voters at the FOMC to have different views regarding the appropriate interest rate, assuming all (regional) information is common knowledge. They find that Fed policy makers take into account regional developments (in addition to national data) when casting votes on monetary policy.

2. Optimal regional representation in a two-country currency union

We investigate the optimal solution for a joint committee, set up by two countries. The total number of committee members (from both countries) is set exogenously to *m,* the variable of choice being the share *x* of representatives from country 1. A straightforward example is a monetary policy committee with a single objective a target for inflation[1]. For simplicity, we assume that the state of the economy can be characterised by a single statistic π_i , which indicates 'inflationary pressure' in the economy. Then, we introduce the idea that aggregate statistics of both countries can be subject to the information uncertainties, assuming that no

[1] Having a single monetary policy target is a simplifying assumption which does not affect our results, as long as the target(s) are common to the currency union members. Heinemann and Huepfner (2004) develop a generalized monetary policy reaction function which allows for an influence of regional divergences.

single committee member can observe the state of the economy as a whole, but every delegate has some local knowledge:

'*…The growing dispersion of economic activity increases the value of local information that Reserve Bank presidents bring to the Federal Open Market Committee. ... Personal contacts are particularly valuable in periods of financial crisis when it is especially difficult to know what is happening in certain sectors. Reserve banks tend to specialize in knowledge concerning industries concentrated in their respective districts…*' (Goodfriend, 1999).

In our model, a higher share of representatives from a country leads to lower information uncertainty, but at a diminishing rate. Put more formally,

$$\pi_i^{est} = \pi_i^{true} + \varepsilon_i, \quad E(\varepsilon_i \mid x_i) = 0, \quad i = 1,2 \tag{1}$$

where π_i^{true} denotes the unobservable true state of the economy in country *i*, π_i^{est} refers to the committee's estimate of the state of the economy *i*, and ε_i is the zero-mean 'judgement error' or estimation error for country *i*. The variance of the judgment error ε_i, and also of the estimate π_i^{est}, has the following properties:

$$Var(\varepsilon_i \mid x_i) = \sigma_i^2 s_i^2(x_i), s_i^2(x_i) > 0, \quad i = 1,2 \tag{2}$$

$$\partial Var(\varepsilon_i \mid x_i)/\partial x_i = \sigma_i^2 \lambda_i(x_i) < 0, \quad \partial^2 Var(\varepsilon_i \mid x_i)/\partial x_i^2 = \sigma_i^2 v_i(x_i) > 0, \quad i = 1,2 \tag{3}$$

According to equation (2), data uncertainty in country *i* equals the product of the intrinsic uncertainty σ_i^2 and the square of a (at least) twice differentiable function s_i of x_i, displaying the properties imposed above (i.e. 'diminishing returns to information').[2] Next, we also assume that estimation errors can be correlated between the countries:

$$Corr(\varepsilon_1, \varepsilon_2 \mid x_1, x_2) = \rho \tag{4}$$

Finally, we assume that the union-wide true and estimated inflationary pressure, π_{CU}^{true} and π_{CU}^{est} are weighted averages of the statistics for the two countries:

$$\pi_{CU}^{est} = \alpha\pi_1^{est} + (1-\alpha)\pi_2^{est} \tag{5}$$

$$\pi_{CU}^{true} = \alpha\pi_1^{true} + (1-\alpha)\pi_2^{true} \tag{6}$$

where the economic weights of the two participating countries, α and 1- α, reflect e.g. differences in economic size. We assume that the joint committee has a single objective, in this case a 'target' for inflation π^*. Policymakers can directly control the state of the economy - which determines inflation[3] - and do not pursue political, regional or strategic considerations when voting. The loss function is given by the deviations of the observed inflationary pressure in the currency union and the target:

$$L = E(\pi_{CU}^{est} - \pi^*)^2 = (E(\pi_{CU}^{est}) - \pi^*)^2 + Var(\pi_{CU}^{est}) \tag{7}$$

[2] A familiar simple example is the computation of a variance of sample average (as an estimator of the population average), which is given as $Var=\sigma^2 s_i^2(x_i)$, $s_i^2(x_i)=1/(x_i*N)$, where σ^2 is the variance of the observed values, *N* is the size of the general population and x_i*N is the size of the sample. In this example $\lambda_i(x_i)=-1/(x_i^2*N)<0$ and $v_i(x_i)=2/(x_i^3*N)>0$.

[3] This assumption is very common in the central banking literature, for instance in the form of a central bank directly controlling inflation (see e.g. Rogoff 1985).

As we can see from equation (7) the loss function of the committee is the sum of two parts: the first part refers to the optimal rule for decision-making, the second to uncertainty about the state of the economy.

Proposition 1 *The optimal rule for decision-making is ex ante invariant to the composition of the committee.*

Proof. Minimization of the first part in equation (7) requires

$E(\pi_{CU}^{est}) - \pi^* = 0$ and hence: $E(\pi_{CU}^{true} - \varepsilon) - \pi^* = 0$.

Since by assumption $E(\varepsilon_i) = 0,\ i = 1,2$, and ε is a weighted sum of the ε_i's, it follows directly that $E(\varepsilon) = 0$. The policy decision is *ex ante* invariant to the composition of the committee.

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Hence, to minimise the total loss function we can concentrate on selecting regional representation in such a way that the likelihood of making an error in the assessment of π, the informational uncertainty, is minimised. This reduces our optimisation problem to:

$$\begin{aligned} \tilde{L} &= Var(\pi_{CU}^{est}) = Var(\alpha\pi_1^{est} + (1-\alpha)\pi_2^{est}) = Var(\pi_{CU}^{true} + (\alpha\varepsilon_1 + (1-\alpha)\varepsilon_2)) \\ &= Var(\alpha\varepsilon_1 + (1-\alpha)\varepsilon_2) \end{aligned} \tag{8}$$

Next, we explore the division of committee members with regard to their country of origin. In other words, we are interested in an optimal solution for $x\,m$, the number of committee members from country 1, on the basis of which the share from country 2 can be calculated as $(1-x)m$ representatives.

Applying definitions (2) to both countries 1 and 2, we can express the loss function (8) as follows:

$$\begin{aligned} \tilde{L} &= \alpha^2 Var(\varepsilon_1) + (1-\alpha)^2 Var(\varepsilon_2) + 2\alpha(1-\alpha)Cov(\varepsilon_1, \varepsilon_2) \\ &= \alpha^2\sigma_1^2 s_1^2(x) + (1-\alpha)^2\sigma_2^2 s_2^2(1-x) + 2\alpha(1-\alpha)\rho\sigma_1 s_1(x)\sigma_2 s_2(1-x) \end{aligned} \tag{9}$$

where subscripts 1 and 2 denote the country-specific elements. Positive correlation between judgment errors means that positive errors and negative errors reinforce one another and the aggregate error in the assessment of the economic situation in the monetary union is likely to be quite large. Negative correlation, on the other hand, means that positive errors in one country are more likely to cancel out against negative errors in the other country and the average assessment for the union is likely to be more correct.

Minimising the loss with respect to *x* requires the following first- and second-order conditions (FOC and SOC) to be met:

$$\begin{aligned} \frac{\partial\tilde{L}}{\partial x} &= \alpha^2\sigma_1^2\lambda_1(x)\left[1 + \rho\frac{(1-\alpha)\sigma_2 s_2(1-x)}{\alpha\sigma_1 s_1(x)}\right] - (1-\alpha)^2\sigma_2^2\lambda_2(1-x)\left[1 + \rho\frac{\alpha\sigma_1 s_1(x)}{(1-\alpha)\sigma_2 s_2(1-x)}\right] \\ &= MRU_1 - MRU_2 = 0 \end{aligned} \tag{10}$$

$$\frac{\partial\tilde{L}^2}{\partial^2 x} = \alpha^2\sigma_1^2 v_1(x) + (1-\alpha)^2\sigma_2^2 v_2(1-x) - \frac{1}{2}\rho\alpha(1-\alpha)\sigma_1\sigma_2\Delta \geq 0 \tag{11}$$

where

$$\Delta = \frac{\lambda_1^2(x)s_2^4(1-x) + \lambda_2^2(1-x)s_1^4(x) + 2s_1^2(x)s_2^2(1-x)\left(\lambda_1(x)\lambda_2(1-x) - s_1^2(x)v_2(1-x) - s_2^2(1-x)v_1(x)\right)}{s_1^3(x)s_2^3(1-x)}$$

In the optimum the marginal reduction in uncertainty in both countries ('MRU_i') must be equal. If both countries are fully symmetric regarding the (weighted) economic uncertainty and the returns to information ($\alpha\sigma_1 s_1(x) = (1-\alpha)\sigma_2 s_2(1-x)$ and $\lambda_1(x) = \lambda_2(1-x)$), it is easily shown that the optimal representation is $x = \frac{1}{2}$, irrespective of the value of ρ. If we assume that the informational uncertainties between the countries are not correlated ($\rho = 0$), we can derive the following proposition:

Proposition 2 *The share of representatives of one country in the joint committee will increase, ceteris paribus: (1) the lower the degree of sectoral specialisation (i.e. the higher the returns to information), (2) the higher the degree of intrinsic uncertainty, or (3) the higher the economic weight of this country.*

Proof. With ($\rho = 0$), FOC (10) and SOC (11) can be simplified to the following:

$$\alpha^2\sigma_1^2\lambda_1(x) - (1-\alpha)^2\sigma_2^2\lambda_2(1-x) = 0$$

$$\alpha^2\sigma_1^2 v_1(x) + (1-\alpha)^2\sigma_2^2 v_2(1-x) \geq 0$$

(1) Using the implicit function theorem, we obtain:

$$\frac{\partial x}{\partial \lambda_1} = -\frac{\alpha^2\sigma_1^2}{\alpha^2\sigma_1^2 v_1(x) + (1-\alpha)^2\sigma_2^2 v_2(1-x)} < 0$$

given assumptions (2) and (3). Note in particular that a lower degree of sectoral specialisation in country 1 implies a reduction in the absolute value $|\lambda_1(x)|$, i.e. an increase in $\lambda_1(x)$.

(2) Again, we obtain:

$$\frac{\partial x}{\partial \sigma_1^2} = -\frac{\alpha^2\lambda_1(x)}{\alpha^2\sigma_1^2 v_1(x) + (1-\alpha)^2\sigma_2^2 v_2(1-x)} > 0$$

(3) Finally, we obtain:

$$\frac{\partial x}{\partial \alpha} = -\frac{2\left(\alpha\sigma_1^2\lambda_1(x) + (1-\alpha)\sigma_2^2\lambda_2(1-x)\right)}{\alpha^2\sigma_1^2 v_1(x) + (1-\alpha)^2\sigma_2^2 v_2(1-x)} > 0$$

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Simply speaking, a lower degree of sectoral specialisation implies that observations of the state of the economy in one country are less likely to be highly correlated or overlapping and hence more representatives are needed to provide a relatively accurate description of the whole.

Now we will investigate how the optimal composition of the committee changes if we allow for nonzero correlation between the two countries, i.e. if $\rho \neq 0$.

Proposition 3 *A representation of the country with, ceteris paribus, either (1) more valuable or (2) more precise information is marginally increasing with the correlation of the observational errors between the countries.*

Proof. The implicit function theorem implies the following:

$$\frac{\partial x}{\partial \rho} = -\frac{\frac{\partial FOC}{\partial \rho}}{\frac{\partial FOC}{\partial x}}$$

Given SOC (11), the denominator is positive. The numerator is given as:

$$\frac{\partial FOC}{\partial \rho} = \alpha^2 \sigma_1^2 \lambda_1(x)\left[\frac{(1-\alpha)\sigma_2 s_2(1-x)}{\alpha\sigma_1 s_1(x)}\right] - (1-\alpha)^2 \sigma_2^2 \lambda_2(1-x)\left[\frac{\alpha\sigma_1 s_1(x)}{(1-\alpha)\sigma_2 s_2(1-x)}\right]$$

This can be rearranged as:

$$\frac{\partial FOC}{\partial \rho} = \alpha\ (1-\alpha)\sigma_1\sigma_2\left[\frac{\lambda_1(x)s_2(1-x)}{s_1(x)} - \frac{\lambda_2((1-x)s_1(x)}{s_2(1-x)}\right]$$

Hence:

$$\frac{\partial x}{\partial \rho} > 0 \Leftrightarrow \frac{\partial FOC}{\partial \rho} < 0 \Leftrightarrow \frac{\lambda_1(x)}{(s_1(x))^2} < \frac{\lambda_2(1-x)}{(s_2(1-x))^2},$$

i.e. the representation of country 1 is increasing in ρ if the information in country 1 is relatively more valuable (that is, if $\lambda_1(x)$ is more negative) or if it is relatively more precise (that is, if $(s_1(x))^2 < (s_2(1-x))^2$).

■

Intuitively speaking, positive correlation between assessment errors in countries 1 and 2, meaning that positive errors and negative errors in the assessments will reinforce one another, marginally increases the number of candidates with more precise or more valuable information, i.e. those whose participation can contribute more to reducing the aggregate uncertainty (the candidates from country 1 in the proof above). Negative correlation, meaning that positive errors in one country are more likely to cancel out against negative errors in the other country and the average inflationary assessment is likely to be more correct, marginally reduces the importance, and the number, of candidates with more precise or more valuable information.

Extending our methodology and findings to larger unions is straightforward. For example, it still holds that a higher degree of sectoral specialisation in one country leads to a decrease in its representation in the joint committee, and that a higher (weighted) degree of intrinsic uncertainty leads to an increase in the representation, ceteris paribus. Also, we can still expect that an increase in correlation between assessment errors in two countries leads to an increase in a representation of the country which candidates have more precise or more valuable information, ceteris paribus.

3. Discussion

In a world where decisions have to be taken under uncertainty, having ‘good information’ is vital. How should a committee look like, if delegates possess private information, and if they represent constituencies of unequal size?

Probably many people's first guess would be that representation should be proportional to economic weight. While such a scheme could be politically appealing, our model indicates

that it is not necessarily *informationally* optimal - in fact, it is rather unlikely that it is informationally optimal. Instead, our analysis indicates that it might be beneficial from an economic point of view to increase the representation of regions with high economic 'uncertainty' above their economic weight in a committee. The flipside of this argument is that a large economic weight of a certain country alone is not sufficient to justify a large representation in a supra-national committee. This holds in particular if representatives from other countries can provide similar information.

This model has a number of interesting implications. Consider, for instance, monetary policy. The decision-making bodies of two most important central banks in the world (the Federal Reserve System and the European System of Central Banks) feature regional representation. However, the regions' weights in the FOMC and the countries' weights in the Governing Council are only loosely related to their economic importance[4]. A key insight of this study is that optimal representation in a committee need not be proportional to economic weight. If the assessment of the state of the economy in smaller regions or countries is more difficult than in large regions – because economies are more specialized or exhibit structural breaks – out model provide some justification for increasing the weight of these economies in the committee beyond their simple economic weight.

Our findings could also be verified in an experimental setting, for example in a monetary policy game played by committees with different compositions for the same sets of parameters. The committees' performance could be then evaluated using the loss function (7), identifying the composition which performs best.[5] We leave this interesting exploration to further research.

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[4] For instance, the Governor of the San Francisco FED votes in 33 percent of all meetings, which is the same voting frequency as the Governor of the, say, St. Louis FED; yet in economic terms the FED district San Francisco is far greater. Overrepresentation of 'small' countries in the Governing Council has prompted concerns that monetary policy might be biased towards the economic needs of small countries (Baldwin *et al.* 2001; Berger 2002; Ullrich 2004), if small EMU members 'dominate' the Governing Council.

[5] For experimental evidence on the performance of monetary policy committees, see for example Blinder and Morgan (2005).

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